THE INFLUENCE OF TRANSFERRING A BATON FROM ONE HAND TO THE OTHER ON RUNNING SPEED

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THE INFLUENCE OF TRANSFERRING A BATON FROM ONE HAND TO THE OTHER ON RUNNING SPEED

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CHAPTER I

INTRODUCTION

As the training methods of runners become more specialized, the difference between winning or losing a race or a meet may be a tenth or even a hundredth of a second. As more coaches and athletes search for newer and better ways to improve, caution should be exercised before jumping on the "bandwagon" with every new method or technique. Many innovations are valid and worthy of being tried, while others may only appear to be the cause for improvement in performance.

I. THE PROBLEM

Statement of the problem. The purpose of this study was to verify or refute the claim of the eclectic baton exchange method that changing the baton between hands while running at full speed has a significant influence on running speed.

Most track coaches advocate the use of the standard sprint relay exchange.[1] This investigator observed that a majority of teams in the 1966 Drake Relays used the standard

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[1]John W. Morriss, "Relay Racing," Athletic Journal, XLIV (March, 1964), 36.

method. In this method the incoming runner carries the baton in his left hand, and places it in the right hand of the next runner. Upon receiving the baton, the receiver immediately switches it to his left hand. The second and third runners in the relay event repeat the process of receiving with the right hand and passing with the left hand.[1]

A comparatively new method of exchanging a baton during sprint relays involves a non-switching or "eclectic" exchange. In this technique each runner keeps the baton in the hand in which he receives it. The first runner starts with the baton in his right hand. The second runner receives the baton in his left hand and places it in the right hand of the third runner. The third runner repeats the process and places the baton in the left hand of the fourth runner.[2]

The advantages claimed for the non-switching, or eclectic, exchange are that primarily it eliminates the cross-body arm motions of the second and third runners,[3] and it also decreases the chances of dropping the baton.[4] Those

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[1]Kenneth D. Miller, "The Relay Exchange," Athletic Journal, XXXIII (March, 1953), 61.

[2]Duane B. Mehn, "An Eclectic Baton Pass," Scholastic Coach, XXXV (February, 1966), 62.

[3]George T. Bresnahan, W. W. Tuttle, and Francis X. Cretzmeyer, Track and Field Athletics (St. Louis: The C. V. Mosby Co., 1960), p. 191.

[4]Mehn, loc. cit.

who oppose its use maintain the confusion which results from having to switch relay personnel does not justify its use.

If the claims of improved running time in the eclectic method could be proven or verified, the advantages of this method might overshadow the disadvantages. However, if the switching of the baton has no appreciable influence on running speed, then the use of the eclectic method would seem somewhat questionable.

Purpose of the study. Theoretically the amount of time that can be gained by perfect baton exchanges in a sprint relay can vary up to a total of 2.5 seconds.[1] In short relay races that require slightly more than forty seconds for the entire race, it becomes quite apparent that each fraction of a second is very important.

The most critical part of a sprint relay is during the baton exchange, and any improvement in this area, no matter how slight, may be of prime importance in a close race.

The standard baton exchange requires that the baton be transferred from the receiving hand to the passing hand. It is generally accepted that this should be done during

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[1] J. Kenneth Doherty, Modern Track and Field (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963), p. 264.

the first stride after receiving the baton. The assumption seems to be that to switch the baton to the other hand while running at top speed reduces the speed of the runner. This investigator has noticed a type of "floating" stride whenever a runner does switch hands in the middle of his sprint. Whether this "floating" action causes a decrease in the runner's speed is the main purpose of this investigation.

Need for the study. Considering the importance of the baton exchange in relay racing, there has been little development in this area. Most track coaches advocate the conventional left to right exchange which requires the runner to transfer the baton from one hand to the other.[1,2] Coaches have generally accepted that the baton must be switched immediately, as all available literature in this regard states that to do so later would influence the speed of the runner.

It is on this premise of the negative influence of switching that some coaches advocate the use of an eclectic baton exchange which does not require the transfer of the baton from one hand to the other.

A careful review of the literature failed to show any statistical evidence to support or refute the claim of the

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[1]W. Harold O'Conner, "Case for the Inside Pass," Scholastic Coach, XXII (March, 1953), 7.

[2]Morriss, op. cit., p. 36.

negative influence of the switching method of baton exchange.

Limitation of the study. This investigator realizes that there are many factors that influence optimum relay exchanges, namely, lane position, body lean, fumbled baton and timing of the runners. This study does not concern itself with these actual exchange factors, but is limited to the switching of the baton from one hand to the other hand after a runner receives the baton.

The testing was limited to twenty-four members of the Mason City, Iowa, high school track team.

II. DEFINITIONS OF TERMS USED

The following terms appear in the context of this study and for the sake of clarity are here defined.

Standard baton exchange. The standard baton exchange is the conventional method of baton exchange in which the runner receives the baton with his right hand and passes it with his left hand.

Eclectic baton exchange. The eclectic baton exchange is a comparatively new method of baton exchange in which each runner keeps the baton in the same hand in which he receives it.

III. PROCEDURES

Twenty-four members of the Mason City High School

track team were chosen at random to serve as the test group. The subjects consisted of six freshmen, ten sophomores, three juniors and five seniors. Six members of the test group had little or no experience in running with a baton. Eighteen of the group were members of relay teams with twelve of these having been members of sprint relay teams.

The test area consisted of two photo-electrically controlled switches placed ten yards apart with the first switch a distance of eighty-four feet from the start. The timing instrument used was a standard hundredth of a second electric timer.

The test area was located in the high school gymnasium, thus eliminating such variables as wind, temperature, and change in running surface. All contestants were instructed in the significance of the study and the importance of doing their best on all trials.

The test consisted of eight trials a day for two consecutive days. During each trial each subject ran singly at full speed through the ten yard time zone. On the first day of testing each subject was instructed to keep the baton in the same hand during the odd numbered trials, and to switch the baton from one hand to the other hand during the even numbered trials. The sequence of switching and not switching the baton from one hand to the other hand was reversed on the second day to eliminate the influence of warm-up.

Times were recorded for each trial. For each subject the mean time was computed for the eight trials in which he did not switch the baton and also the mean time for the eight trials in which he switched the baton. Mean times were computed for the entire test group, both in the switching and non-switching trials. From this, the time variance for each boy was determined, thus enabling the investigator to utilize Fisher's "t"-score test for small samples[1] to determine whether or not there was a significant influence of baton switching on running speed.

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[1] Charles D. Hodgman, Mathematical Tables (Cleveland, Ohio: Chemical Rubber Publishing Company, 1954), pp. 216-217.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of the review of literature was to ascertain the extent to which this problem had been investigated, and also what related investigations might be utilized in the performance of this study.

The baton exchange. The importance of the baton exchange in sprint relays cannot be overemphasized. Baton passing is a learned activity and must be learned by more members of the track squad than any other single activity.[1] The amount of time that theoretically can be gained by perfect passing will vary up to a total of 2.5 seconds. It was estimated that the 1936 American Olympic 400 meter team gained only 1.5 seconds because of poor passing.[2]

Important as the baton exchange is, the success of a particular relay team may or may not be due to the type of baton pass used. The cradle type baton pass used by the American Olympic sprint relay teams of 1932, 1936 and 1948 was considered as being quite inefficient. Even though

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[1]Richard A. Larkin, "Improved Techniques in Speed Relay Baton Exchanges," Athletic Journal, XLVII (January, 1967), 9.

[2]J. Kenneth Doherty, Modern Track and Field (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963), p. 264.

they won and broke records, this type of baton exchange is rarely ever used today.[1]

There are four preferred methods of blind or non-vision baton exchanges. The cupped right hand on the hip with the palm up, the right thumb on the hip with the fingers pointing down and the two variations of the arm extended to the rear (palm up and palm down) are the four generally accepted methods.[2,3] The arm extended to the rear is the most common used type of exchange. Ninety-five per cent of the sprint relay teams use the standard arm extended back, palm down exchange.[4] The safest of the sprint passes is the cupped hand on the hip. This method does, however, lose yardage as the incoming runner must get closer to his teammate to complete the pass.[5]

The type of baton pass to be used by a particular team may depend on several factors such as:

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[1] Ibid., p. 262.

[2] Jesse P. Mortensen and John M. Cooper, Track and Field For the Coach and Athlete (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1959), pp. 42-43.

[3] George T. Bresnahan, W. W. Tuttle, and Francis X. Cretzmeyer, Track and Field Athletics (St. Louis: The C. V. Mosby Co., 1960), p. 143.

[4] John W. Morriss, "Relay Racing," Athletic Journal, XLIV (March, 1964), 36.

[5] Don Canham and Tyler Micoleau, Track Techniques Illustrated (New York: The Ronald Press Co., 1952), p. 85.

1. The distance of the relay race. (In sprint relays the nonvisual method is adopted, and in longer races the visual method is used.)
2. The mechanical efficiency of the arm-hand styles.
3. The adaptability of the style to the athletes.
4. The degree of certainty that a particular style provides.
5. The amount of free distance gained by the forward reach of the passer and the backward reach of the receiver.
6. The style providing optimum speed for both the receiver and the passer at the instant of transfer.
7. The distance of the receiver's target from the back line of the passing zone if the nonvisual method is selected.[1]

Arm action and running stride. The most commonly used baton exchange is the arm extended back with the palm down. In this method the baton must be transferred from one hand to the other before reaching the next runner. This should be done at a time when it will least affect the running stride. Most coaches feel this should be done immediately.[2,3,4] Some coaches are of the opinion that the baton should not be switched immediately because this delays the outgoing runner in using his arms to aid in his attaining full speed.[5] Other coaches believe that the baton

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[1]Bresnahan, Tuttle and Cretzmeyer, op. cit., pp. 146-147.

[2]Mortensen and Cooper, op. cit., p. 46.

[3]Bresnahan, Tuttle and Cretzmeyer, op. cit., p. 146.

[4]Donn Kingle, Practical Track Athletics (New York: The Ronald Press Co., 1957), p. 180.

[5]Ibid.

should be switched later while running at top speed.

There are two basic methods of transferring the baton from one hand to the other. The inverted method is used when the extended arm, palm up pass is used and the orthodox method is used in the extended arm, palm down exchange. In the inverted method the baton is momentarily grasped by both hands as a person would usually grasp the handle of a lawn mower. In the orthodox method the hands grasp the baton in the same manner a person would in climbing a rope.[1]

The primary concern of most coaches who oppose the use of a conventional switch type exchange is the loss of running speed while the runner is changing the baton from one hand to the other. The use of proper arm action obviously is extremely important in starting. As a sprinter leaves the blocks, he should have tremendous arm action.[2] In starting, the force of the arm swing is proportional to the force of the leg drive.[3] During the race, as well as at the start, the arm action is used to compensate for the leg drive, maintain body alignment,[4] generate power and

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[1] Ibid., p. 181.

[2] Mortensen and Cooper, op. cit., pp. 26-27.

[3] Bresnahan, Tuttle and Cretzmeyer, op. cit., p. 69.

[4] Canham and Micoleau, op. cit., p. 24.

momentum.[1] As the runner reaches full running speed the arms gradually decrease their pumping action, the vigor and scope of the arm movement is lessened and takes on a more rhythm like movement.[2]

Doherty stated that the direct power effects of the arm action in sprinting are zero. The effects of the forward swing are nullified by the backward swings.[3]

Bresnahan, Tuttle and Cretzmeyer have broken the sprint into three component parts: (1) starting strides; (2) transitional strides; and (3) full speed strides. In starting the arm swing is powerful. In the transitional and full speed strides the primary function of the arms is for balance thus keeping the trunk aligned in the direction of the run.[4]

According to Bunn most college sprinters reach their maximum speed in approximately forty-five to sixty feet.[5] Theoretically the outgoing runner on a sprint relay team should be at or near top speed as he receives the baton.

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[1]Kingle, op. cit., p. 65.

[2]Mortensen and Cooper, loc. cit.

[3]Doherty, op. cit., p. 80.

[4]Bresnahan, Tuttle and Cretzmeyer, op. cit., pp. 68-70.

[5]John W. Bunn, Scientific Principles of Coaching (New York: Prentice-Hall, Inc., 1955).

With the addition of eleven more yards to the exchange zone (Olympic style) a runner now has ninety-nine feet with which to attain maximum speed. Mortensen and Cooper stated that the first few strides after leaving the blocks should be fairly long.[1] In the early 1930's it was generally accepted that a sprinter should start with a series of short choppy strides.[2] Fenn found that the faster runners have a longer length stride and a faster number of strides per second.[3] Another very important part of running is the ability to run relaxed. When a runner relaxes there is no loss of speed and many times there is an increase in speed. Young sprinters have a tendency to run strained and tighten up when faced with competition.[4]

Conventional exchange. The advocates of the conventional switch type baton exchange claim that the right hand is less likely to drop the baton and should be used as the receiving hand. The runner receiving the baton with his left hand, especially at full sprint, is not as steady

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[1]Mortensen and Cooper, loc. cit.

[2]Wallace O. Fenn, "Work Against Gravity and Work Due to Velocity Changes in Running: Movement of the Center of Gravity Within the Body and Foot Pressures on the Ground," American Journal of Physiology, XCIII (May, 1930), 16.

[3]Ibid., p. 17.

[4]Doherty, op. cit., p. 80.

as when he receives it with his right.[1] One objection to the eclectic or non-switch exchange is the possibility of having to change the positions of the relay personnel.[2] Another disadvantage is having the hand too far toward the receiver's end of the baton. When this happens, the runner generally presses the baton against his thigh or abdomen. It appears reasonable to assume that running speed is affected whenever this is done.[3]

In the non-switch exchange, the passer is usually instructed to bring the baton down firmly into the palm-up hand of the receiver.[4] During the 1967 Drake Relays the investigator noted whenever an incoming runner missed in his downward thrust of the baton, he would generally experience extreme difficulty in raising the baton again for a second downward thrust. During these same Drake Relays the third runner on the Southern University 880 yard relay team lost his balance during such a pass and fell down. Having failed to get the baton to the fourth runner, the team was deprived of its bid for a possible record.

Lavery, track coach at Indiana University, commented,

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[1]Kingle, op. cit., p. 181.

[2]Doherty, op. cit., p. 265.

[3]Bresnahan, Tuttle and Cretzmeyer, op. cit., p. 146.

[4]Duane B. Mehn, "An Eclectic Baton Pass," Scholastic Coach, XXXV (February, 1966), 62-63.

"I've tried them all and I prefer the standard palm down method primarily because it is efficient as well as comparatively safe."[1]

Eclectic exchange. The eclectic, or non-switch, baton exchange is a combination of both the outside-right hand receive and the inside receive exchange. Mehn claimed this method is preferable for three reasons: (1) It enables the receiver to run normally with only a slight change in running form; (2) It insures having something between the baton and the ground; and (3) It furnishes more distance between the passing and receiving runners than does other techniques.[2]

One of the greatest dangers of the conventional switch hands type exchange is the danger of dropping the baton in the process of switching hands.[3,4] The eclectic baton pass removes this danger by eliminating the switch.[5]

Doherty claimed that the gains made by using this method are real in that the momentary loss of arm action,

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[1]Opinion expressed by Coach Jim Lavery at the 1966 Drake Relays.

[2]Mehn, loc. cit.

[3]Doherty, op. cit., p. 265.

[4]Bresnahan, Tuttle, and Cretzmeyer, op. cit., p. 146.

[5]Mehn, loc. cit.

as the baton is switched, is not present. An appreciable gain in time is therefore made.[1] Doherty also stated, however:

> that the direct power effects of the arm action in sprinting are equal to zero. Not only are the arms of relatively low weight, compared with those of the body but the effect of the forward swings, whether fast or slow, whether vigorous or completely relaxed, is nullified by the backward swings, no matter how the former are emphasized in the mind of the sprinter or coach.[2]

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[1] Doherty, loc. cit.

[2] Ibid., p. 80.

CHAPTER III

PRESENTATION OF DATA

The purpose of this study was to determine if transferring the baton from one hand to the other hand while running at full speed had a significant influence on running speed. Twenty-four members of the Mason City, Iowa, high school track team were chosen at random to serve as the test group. The test area consisted of two photo-electrically controlled switches placed ten yards apart, located in the high school gymnasium. Each subject ran eight trials a day for two consecutive days. During each trial each subject ran singly at full speed through the ten yard time zone.

On the first day of testing each subject was instructed to keep the baton in the same hand during the odd numbered trials. During the even numbered trials each subject was to switch the baton from one hand to the other.

Table I shows the results of the first day of testing. The mean of the four no switch trials and the mean of the four switch trials were calculated for each individual and the difference between the means determined. It is interesting to note that five of the twenty-four subjects increased in speed (as shown by the negative numbers) during the switching phase of the test. Eight subjects had a

TABLE I

TIMES OF SELECTED MASON CITY, IOWA HIGH SCHOOL STUDENTS, RUNNING TEN YARDS, NOT SWITCHING AND SWITCHING BATON BETWEEN HANDS, FIRST TEST

Trial No.	1	2	3	4	5	6	7	8	mean	mean	difference between mean
Subject	no switch	switch	no switch	switch	no switch	switch	no switch	switch	no switch	switch	switch and no switch
1	1.14	1.11	1.14	1.14	1.17	1.13	1.15	1.17	1.150	1.137	-.013
2	1.09	1.14	1.08	1.12	1.13	1.10	1.17	1.14	1.117	1.125	.008
3	1.07	1.05	1.04	1.07	1.05	1.10	1.10	1.07	1.065	1.072	.007
4	1.00	1.03	1.04	1.03	1.02	1.05	1.13	1.13	1.047	1.060	.013
5	1.12	1.15	1.18	1.20	1.20	1.19	1.24	1.21	1.185	1.187	.002
6	1.14	1.09	1.11	1.09	1.11	1.12	1.13	1.09	1.122	1.097	-.025
7	1.10	1.10	1.09	1.12	1.14	1.15	1.14	1.16	1.117	1.132	.015
8	1.11	1.13	1.13	1.14	1.16	1.20	1.15	1.16	1.137	1.157	.020
9	1.05	1.08	1.07	1.13	1.10	1.11	1.10	1.12	1.080	1.110	.030
10	1.15	1.16	1.14	1.17	1.15	1.20	1.17	1.16	1.152	1.172	.020
11	1.15	1.22	1.14	1.14	1.13	1.15	1.16	1.17	1.145	1.170	.025
12	1.13	1.11	1.11	1.17	1.10	1.15	1.12	1.14	1.115	1.142	.027
13	1.06	1.06	1.12	1.07	1.11	1.12	1.14	1.13	1.107	1.095	-.012
14	1.11	1.07	1.06	1.10	1.12	1.14	1.13	1.14	1.105	1.112	.007
15	1.06	1.05	1.09	1.07	1.09	1.08	1.08	1.07	1.080	1.067	-.013
16	1.28	1.29	1.26	1.32	1.29	1.29	1.28	1.30	1.277	1.300	.023
17	1.11	1.09	1.13	1.11	1.12	1.10	1.16	1.12	1.130	1.105	-.025
18	1.10	1.08	1.07	1.09	1.11	1.11	1.10	1.10	1.095	1.095	.000
19	1.07	1.07	1.03	1.06	1.08	1.10	1.09	1.09	1.067	1.080	.013
20	1.06	1.06	1.04	1.05	1.05	1.07	1.08	1.09	1.057	1.067	.010
21	1.09	1.16	1.12	1.16	1.12	1.15	1.16	1.18	1.122	1.162	.040
22	1.07	1.06	1.07	1.08	1.08	1.10	1.10	1.08	1.080	1.080	.000
23	1.11	1.10	1.09	1.12	1.13	1.12	1.14	1.16	1.117	1.125	.008
24	1.10	1.13	1.10	1.08	1.09	1.10	1.12	1.11	1.102	1.105	.003
							Total Mean		1.115	1.123	.0076

decrease in running speed from .000 to .010 of a second. The remaining eleven runners ranged from .013 to .040 of a second in loss of running speed. The mean difference for all twenty-four subjects was a decrease in running speed of .0076 of a second.

On the second day of testing each subject was instructed to switch the baton from one hand to the other during the odd numbered trials and to keep the baton in the same hand during the even numbered trials.

Table II shows the results of the second day of testing. The mean of the four switch trials and the mean of the four no switch trials were calculated and the difference between the means determined. Two subjects increased in running speed during the switching phase of the test (.018 and .035 of a second). Eleven subjects had a decrease in running speed that ranged from .000 to .010 of a second with the remaining eleven losing from .013 to .035 of a second. The mean difference for all twenty-four subjects was a decrease in running speed of .0091 of a second.

In establishing the reliability of the first day of testing to the second day of testing, the product moment correlation for computing "r" on the basis of raw scores was used.[1] This computation resulted in a correlation of .70.

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[1]Deobold B. Van Dalen, Understanding Educational Research (New York: McGraw Hill Book Company, Inc., 1962), pp. 288-289.

TABLE II

TIMES OF SELECTED MASON CITY, IOWA, HIGH SCHOOL STUDENTS, RUNNING TEN YARDS, SWITCHING AND NOT SWITCHING BATON BETWEEN HANDS, SECOND TEST

Trial No.	1	2	3	4	5	6	7	8	mean	mean	difference between mean
Subject	no switch	switch	no switch	switch	no switch	switch	no switch	switch	no switch	switch	switch and no switch
1	1.19	1.15	1.14	1.20	1.15	1.15	1.19	1.17	1.167	1.167	.000
2	1.13	1.11	1.16	1.17	1.12	1.10	1.14	1.14	1.130	1.137	.007
3	1.08	1.05	1.08	1.14	1.10	1.07	1.06	1.06	1.080	1.080	.000
4	1.08	1.08	1.12	1.13	1.08	1.08	1.05	1.04	1.082	1.082	.000
5	1.24	1.19	1.29	1.27	1.15	1.18	1.25	1.22	1.215	1.232	.017
6	1.10	1.13	1.13	1.14	1.16	1.12	1.16	1.16	1.137	1.137	.000
7	1.17	1.16	1.18	1.15	1.16	1.14	1.15	1.13	1.145	1.165	.020
8	1.18	1.15	1.16	1.19	1.18	1.17	1.20	1.18	1.172	1.177	.005
9	1.16	1.14	1.13	1.11	1.13	1.15	1.18	1.12	1.130	1.150	.020
10	1.23	1.21	1.21	1.21	1.22	1.20	1.30	1.29	1.227	1.240	.013
11	1.21	1.14	1.26	1.21	1.18	1.22	1.19	1.22	1.197	1.210	.013
12	1.17	1.14	1.20	1.12	1.15	1.12	1.17	1.13	1.127	1.172	.045
13	1.12	1.11	1.16	1.14	1.17	1.18	1.20	1.18	1.152	1.162	.010
14	1.20	1.14	1.14	1.18	1.20	1.17	1.20	1.11	1.150	1.185	.035
15	1.15	1.15	1.18	1.20	1.18	1.17	1.20	1.17	1.172	1.177	.005
16	1.30	1.26	1.37	1.34	1.36	1.35	1.36	1.37	1.330	1.347	.017
17	1.12	1.19	1.09	1.13	1.11	1.11	1.09	1.12	1.137	1.102	-.035
18	1.08	1.05	1.10	1.14	1.11	1.11	1.14	1.13	1.107	1.115	.008
19	1.13	1.10	1.09	1.10	1.12	1.11	1.10	1.11	1.105	1.110	.005
20	1.14	1.13	1.18	1.15	1.17	1.17	1.21	1.16	1.152	1.170	.018
21	1.17	1.15	1.18	1.14	1.18	1.16	1.22	1.18	1.157	1.187	.030
22	1.07	1.09	1.08	1.10	1.08	1.09	1.10	1.12	1.100	1.082	-.018
23	1.11	1.12	1.13	1.14	1.16	1.14	1.16	1.15	1.137	1.140	.003
24	1.14	1.14	1.14	1.18	1.20	1.14	1.18	1.20	1.165	1.165	.000
							Total Mean		1.153	1.163	.0091

Table III shows the mean of the total switch and no switch trials for each subject. The difference between these means resulted in the total amount of time lost or gained by each subject during the switching phase of the test. The mean difference between the switching and non switching trials of all subjects was .0084 of a second. Five subjects had increased in running speed during the switching phase of the test from .004 to .030 of a second. Eight subjects had a decrease in running speed from .002 to .010 of a second, while the remaining eleven had a decrease in running speed from .012 to .036 of a second.

Fisher's t test of significance between two sample means was used as the basis of testing the hypothesis that there was no statistically significant difference between the means of the switch and non-switch trials. Using the hypothesis that the mean of the switch trials equals the mean of the non-switch trials it was found that t (.6081) falls outside the critical region in both the five per cent and the one per cent levels of confidence tests.[1] Therefore it must be accepted that this hypothesis is correct and conclude that there is no significant difference in the time involved in the two methods of baton switching.

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[1]Van Dalen, op. cit., p. 387.

TABLE III

MEAN TIMES OF TWO TESTS, SELECTED MASON CITY, IOWA HIGH SCHOOL STUDENTS, RUNNING TEN YARDS, NOT SWITCHING AND SWITCHING BATON BETWEEN HANDS

Subject	Total Mean No Switch	Total Mean Switch	Total Mean Difference
1	1.158	1.152	-.006
2	1.123	1.131	.008
3	1.072	1.076	.004
4	1.065	1.071	.006
5	1.200	1.210	.010
6	1.130	1.117	-.013
7	1.131	1.148	.017
8	1.155	1.167	.012
9	1.105	1.130	.025
10	1.189	1.206	.017
11	1.171	1.190	.019
12	1.121	1.157	.036
13	1.128	1.128	.000
14	1.127	1.148	.021
15	1.126	1.122	-.004
16	1.103	1.323	.020
17	1.133	1.103	-.030
18	1.101	1.105	.004
19	1.086	1.095	.009
20	1.105	1.119	.014
21	1.140	1.175	.035
22	1.090	1.081	-.009
23	1.127	1.133	.006
24	1.133	1.135	.002
Grand Mean	1.134	1.143	.0084

CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to determine if switching a baton from one hand to the other while running at full speed has a significant influence on running speed.

The investigative procedures included a review of related literature and an analysis of data obtained from a testing program. The testing procedures consisted of selecting at random twenty-four members of the Mason City High School track team to serve as the test group. The test area consisted of two photo-electrically controlled switches placed ten yards apart, located in the high school gymnasium. The timing device consisted of a standard hundredth of a second timer. Each subject ran eight trials a day for two consecutive days. During each trial each subject ran singly at full speed through the ten yard time zone. On the first day of testing each subject kept the baton in the same hand during the odd numbered trials. During the even numbered trials each subject switched the baton from one hand to the other. The order of switching and not switching was reversed during the second day of testing.

II. CONCLUSIONS AND RECOMMENDATIONS

Based on the statistical analysis of the obtained data, and within limitations of the sample and techniques employed, there was no significant difference in time between switching or not switching the baton from one hand to the other hand while running at full speed. The mean loss of time for all subjects was .0084 of a second. The "t" ratio (.6081) between the switching and non-switching trials falls outside the critical region in both the five per cent and the one per cent levels of confidence tests.

A few subjects seemed to be influenced more than others during the switching phase of the test. Some subjects ran significantly faster while others ran significantly slower when they switched the baton. The differences in running speed may have been attributed to a longer or "floating" stride which was quite apparent with most of the runners during the switching phase of the test. Most of the subjects whose running speed was increased during the switching phase had, according to the investigator, a choppy type stride. Inexperience seemed to be more prevalent among those subjects whose running speed had substantially decreased during the switching phase of the test.

On the basis of the information obtained in this study, the following conclusions are presented:

1. In general, the switching of the baton from one hand

to the other, while running at full speed, has no statistically significant influence on running speed.

2. Experienced runners with a well developed stride were generally not significantly influenced by the switching of the baton.
3. The time saving advantages claimed by the advocates of the eclectic or non-switch baton exchange would seem to be unfounded.
4. The switching of the baton in the standard baton exchange might be more effective if it is done after the outgoing runner has taken several strides instead of immediately as most coaches now advocate.
5. Factors other than the switching of the baton from one hand to the other should determine the type of baton exchange used.

The results of this limited study cannot be considered conclusive. The investigator recommends that this study be used as a guide to other studies regarding the problem of baton switching as well as other areas relative to the baton exchange.

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